Autonomous Oceanographic Sampling Using Environmentally-Powered Gliding Vehicles

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LONG-TERM GOALS

Our long-term goal is to develop a flexible system of autonomous gliding vehicles suitable for extended oceanographic exploration in both coastal and blue-water environments. We place particular emphasis on the development and application of high-endurance, low-cost, intelligent vehicles capable of coordinated operation within the framework of an autonomous oceanographic sampling network. Our strategy is to combine technology development activities with well-defined and important oceanographic research efforts through a series of increasingly complex field experiments.

OBJECTIVES

The primary objective of this program is to demonstrate moderate-term (weeks to months) operation of a multi-vehicle network of environmentally-powered Slocum autonomous gliders while collecting physical (CTD) and bio-optical (fluorometer, transmissometer, PAR) measurements in the vicinity of the Bermuda Atlantic Time Series (BATS) station in the subtropical North Atlantic. Secondary objectives include continued development of a multi-vehicle communication and control infrastructure and field tests of sampling and sensor intercalibration schemes

APPROACH

We will construct and deploy three environmentally-powered Slocum gliders. The nominal patrol area for the Slocum fleet will be within a 75 km radius circle surrounding the BATS station and extending to a depth of 1500 m. The vehicles will be instructed to occasionally cross paths with each other to provide sensor intercalibration opportunities, to sample the BATS site coincident with R/V Weatherbird II occupations, and to respond to interesting mesoscale features (eddies, fronts) identified using satellite remote sensing products.

WORK COMPLETED

A prototype environmentally-powered Slocum glider (built by Webb Research Corporation, East Falmouth, MA) completed 17 successful missions in Lake Seneca during August 2000. Performance of the thermal engine in this deep, well-stratified lake was excellent. A major redesign of the vehicle has resulted in refinement of its hydrodynamic performance and near-surface stability. A second

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14. ABSTRACT

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round of controlled-environment field trials at Lake Seneca was performed fall 2000 prior to beginning construction of two new vehicles this spring. The unique thermal engines have been redesigned to improve efficiency and incorporate an auxiliary booster pump enabling electrically-powered buoyancy changes when oceanic conditions are unsuitable for environmentally-powered operation.

A prototype shore-based automated glider control and data archive system has been developed and is undergoing initial operational trials. We have also developed a simple but powerful desktop-based Slocum mission simulator which allows efficient prototyping of new sampling algorithms including autonomous adaptive sampling based on observed parameters. This simulator allows multiple-vehicle interaction with arbitrary, realistic environmental forcing (winds, tides, currents, etc.).

A custom bio-optical sensor package suitable for long-term deployment on a glider is presently under construction. Development of global satellite communications capability (Iridium) is ongoing and is viewed as a critical requirement prior to long-term unattended operation.

IMPACT/APPLICATIONS

The development of the environmentally-powered Slocum glider will facilitate extended oceanographic research in remote locations that are physically or economically difficult to visit with manned research vessels. Continued development of multi-vehicle network operation will enable autonomous, adaptive measurement of time-dependant or transient ocean phenomena such as mesoscale eddies and fronts. In the future, we believe a network of autonomous gliding vehicles will supply, in an efficient and cost-effective manner, high-quality, near-real-time environmental information for operational ocean/atmosphere forecasting and model validation.

RELATED PROJECTS

This work is supported through the ONR 322OM National Oceanographic Technology program. Development of a companion coastal observing network based on electrically-powered Slocum gliders on the New England continental shelf is underway. We anticipate that continued parallel development of these closely-related vehicle systems will yield rapid improvements in vehicle performance and observational capabilities.

PUBLICATIONS

Fratantoni, D.M. and D.A. Glickson, *The Slocum Autonomous Glider*, presented at AGU Fall Meeting, San Francisco, CA, December 2000.

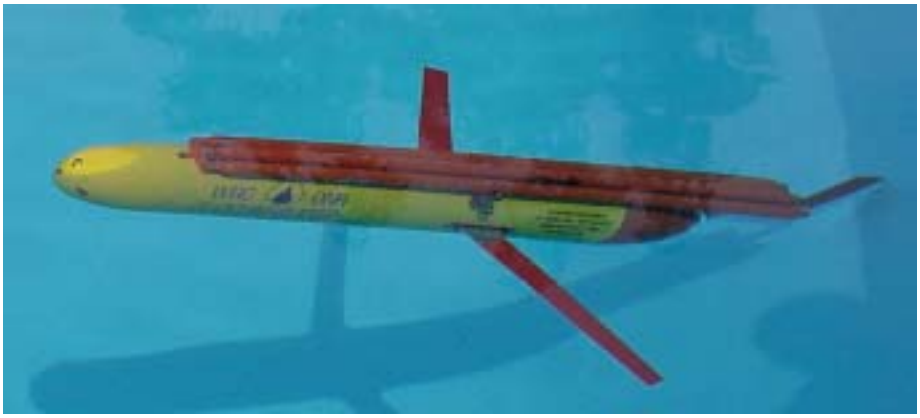

Figure 1: Prototype environmentally-powered Slocum glider performing check-out dives prior to deployment in Lake Seneca. The dorsal tubes are heat exchangers associated with the glider's unique thermal engine. All antennae are located in the vertical tail fin.

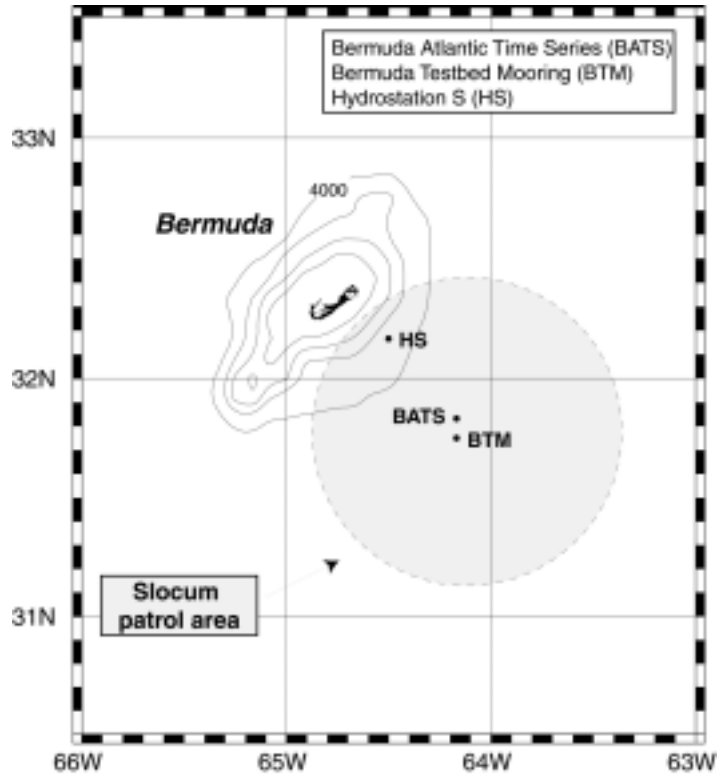

Figure 2: Proposed patrol area for the network of three environmentally-powered Slocum gliders. Locations of experimental sites regularly occupied by R/V Weatherbird II are also shown.